JULIAN HUXLEY

AT THE ZOO

Simply written but memorable essays on animal biology. While they arise chiefly out of observations which can be made at the Zoo, they deal with subjects more widely interesting, such as the meaning of colours in animals, animal reproduction, where animals come from, and how we can study evolution at the Zoo. Thus, the book is essential to Zoo visitors and to animal lovers everywhere. The author, who is, of course, well-known as a biologist and as a writer, has been Secretary of the London Zoological Society since 1935.

(For press opinions please see other flap)

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PLATE I.—Few will regret the passing of the hippopotamus from Britain's shores

Julian Huxley

Secretary to the Zoological Society of London

AT THE ZOO

with 15 plates

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1

What Animals Eat

1

What Animals Eat

EVERYBODY, I hope, enjoys going to the Zoo. At any rate we do our best to make a visit there attractive and entertaining. But zoos are not merely places of entertainment. They are living museums; and as with any other museums, you can get much more out of them, both in enjoyment and interest, if you know what to look for. In this book I am going to try to give an account of some of the things which can add interest to a Zoo visit. The London Zoo is the biggest zoo in the country, and indeed has on exhibit the largest and most varied collections of animals in the world. But there are quite a number of others—for instance, at Bristol, Edinburgh, Manchester, Liverpool, Oxford, Belfast, and Dublin. And at all good zoos you will find some general points of interest, though each will have its own character and its own special features.

Perhaps the first thing that interests people is what the animals in the Zoo eat. The total quantities are enormous. For instance, the year's diet-sheet contains items such as these: meat, 270 tons; hay, 145 tons; clover, 140 tons; monkey nuts, 3 tons—not to mention 200,000 bananas, 21 tons of biscuits, and 6 hundredweights of dried flies.

But more interesting than mere totals are the individual menus of different animals. The scientific discoveries of the last twenty years concerning vitamins and other accessory food factors have been utilized to the full in the Zoo, and have led to notable improvements in the health of various animals, as well as encouraging reproduction in a number of cases.

Gorillas have always been considered very difficult to keep in captivity. However, we now have a fine healthy pair. But we should not, I am sure, have had such success with them if we hadn't given them a physiologically adequate diet. This is what each of them gets daily: 2 lb. grapes, the same of apples, 6 bananas, 3 oranges, some rhubarb, tomatoes, lettuce, onions and carrots with plenty of greens, half a loaf of bread, 1 oz. butter, 1 or 2 eggs, a quart of fresh milk (tuberculosis-free and irradiated), half a tin of condensed milk, a little porridge, and some weak tea. In addition, they get boiled chicken or meat three times a week, and various vitamin and special health preparations.

Booboo and Jubilee get different though equally elaborate diets, and thrive on them. I wish all the children of this country enjoyed as good food as their ape cousins in the Zoo! If so, the national physique and health would be very considerably better than it is.

It used to be thought impossible to keep humming birds in captivity, as in nature they live on the nectar and tiny insects they find in flowers. To-day, however, they live and thrive in a number of zoos. This has been made possible entirely by finding the right food. We give them a synthetic food, made of honey, condensed milk, a proprietary patent food, and a little meat extract. This is provided in special bottles with a tube at the side at which they can sip. In addition, tiny fruit-flies are kept breeding, and clouds of them released in the cage: these provide the needful animal food.

Anteaters, again, are tricky creatures to feed. In nature they live only on live ants and termites. In the Zoo we have found they will thrive on a mixture of minced raw meat, raw eggs, condensed milk, and ants' eggs—about 1½ pints daily.

The fact that all fresh milk used in the Gardens is certified tuberculosis-free and irradiated with ultra-violet light to increase its content of Vitamin D has led to a marked improvement in the health of delicate animals such as apes and various monkeys. Again, the lions and tigers and other large carnivores used to be fed exclusively on horseflesh. To-day this is supplemented with raw liver and various vitamin preparations; in consequence they no longer suffer from rickets, and their general condition has improved.

I could multiply examples of interesting special menus—the manatees' exclusive diet of lettuce, chicory, and endive, or the vampire bats' restriction to blood; and special points about diet, such as the unexpected fact that the marmosets from the inland forests of South America like sea-fish, and thrive better when it is added to their rations. But I want to have plenty of time to talk about a rather different point, namely, the way in which different animals are adapted for dealing with their special food.

A lion is an obvious example. Lions in

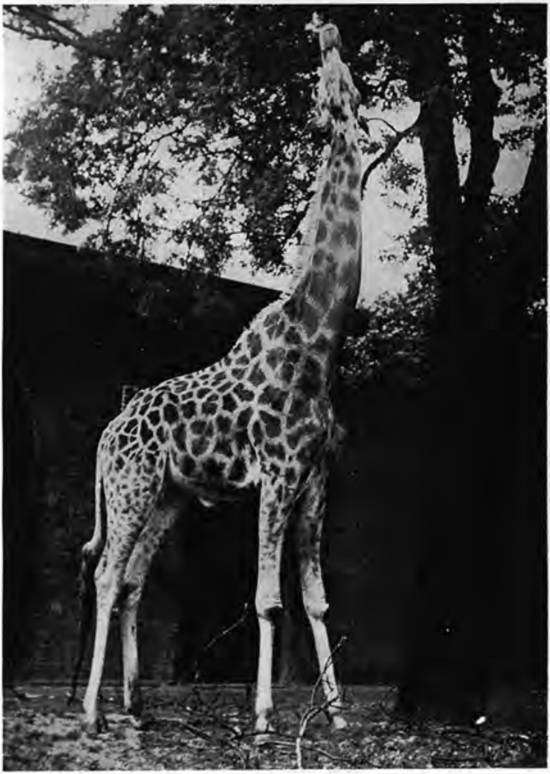

Plate 2.—Giraffe feeding

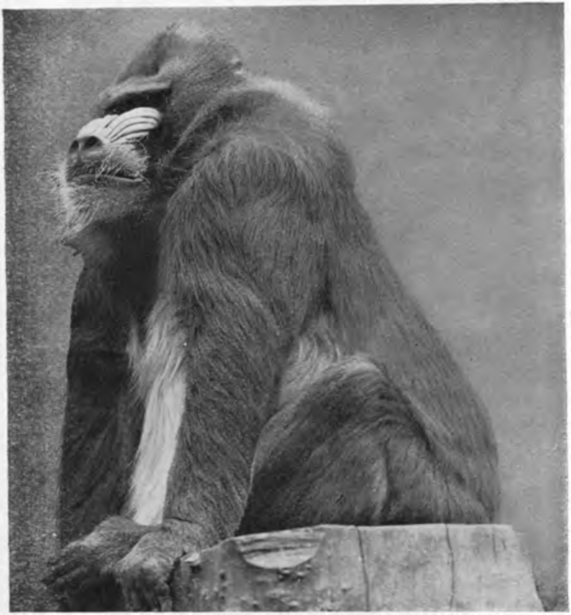

PLATE 3.—The male mandrill advertises his fighting qualities by his face-décor, and so warns off rivals

nature live entirely on the meat of large animals, such as zebra and antelopes, which they catch and kill for themselves. They are therefore constructed so as to be able to leap astonishing distances on their prey, and have an immensely powerful build so as to be able to kill it quickly. Their dog-teeth are very big, and their molar teeth are shaped so as to cut through flesh and sinew. Their claws are long and powerful so as to get a firm grip, and, like a cat's, are provided with a sheath into which they can be withdrawn out of the way when not in use. Hyaenas are also carnivorous, but they do not usually kill their prey like lions; they trail wounded animals, or make a meal off the remains of a lion's kill. Accordingly they are not nearly so powerfully built, especially in the hindquarters; but their teeth are amazingly efficient, so that they can break up large bones with them. The teeth of a giraffe, on the other hand, are like those of other purely herbivorous mammals, such as oxen, antelopes, sheep, and horses, in being built for grinding. They are flat-topped and ridged, so as to serve as miniature millstones, but are not of the slightest good for cutting.

If you are lucky you will see a giraffe chewing the cud. The neck is stretched out, and slowly, like an old-fashioned lift, a lump about the size of a man's fist passes up that enormous length into the mouth, there to be chewed and later re-swallowed. This method of dealing with food is found in all the ruminants—giraffes, cattle, buffaloes, antelopes, sheep, deer, and camels. It, too, is an adaptation. Vegetable food demands much chewing, but to do so on the spot would expose the animal to danger from its enemies. So it bolts its food quickly, and only later when it is in some safer retreat brings it up again into the mouth to chew properly. When the giraffe puts out its tongue, you will see it is enormously long. This is an adaptation to allow it to pick off leaves from among the formidable thorns of the thorn trees on which it feeds, while the long neck is an obvious adaptation allowing it to reach otherwise untapped sources of food.

The great anteater has an even longer tongue than the giraffe. It has been evolved for thrusting into ants' and termites' nests and picking up the ants. The long snout helps the same end. The huge claws on the forefeet serve to tear down the strong walls of the nests. They are so big that they would be awkward to walk on, and walking on them would blunt their sharp points. Accordingly, as a further adaptation, the anteater's arms are constructed so that he has to walk on the side of his knuckles. Thus the anteater is a bundle of adaptations, all connected with its specialized diet.

Birds show a number of obvious and striking adaptations to the kind of food to which their instincts restrict them. These are perhaps most obviously shown in the shape and construction of their beaks. Seed-eating birds like finches and sparrows, as you can see in the Bird House, have powerful, almost conical beaks, while those of insect-eating birds like robins and warblers are slender and much weaker. The large beaks of toucans and hornbills are adaptations for picking and holding large fruits. The hornbills show a further obvious adaptation in the saw-like edges of the beaks, which give a better grip on the fruit. Eagles and hawks have powerful hooked beaks for tearing flesh. So do owls, though they are not related to hawks: here, as often, similar needs have produced similar results. In the Waders Aviary you can see godwits and ruffs with long, straight bills; these serve to plunge deep into mud or sand to extract worms and other burrowing animals. The flamingos on Three Island Pond have very queer-looking bent beaks. These are elaborately ridged and grooved inside, and serve to lift small animals and plants out of mud and water. The shape of the beak permits it to be used upside-down, on the floor of the shallow pools where they chiefly feed. So one might go on: the white pelican has a fish-scoop for the lower half of its bill, the heron has its beak turned into a fish-spear, the woodpecker's is a hammer and chisel. All these and many more you can see in the Zoo.

In some of the most remarkable cases it is not so easy to see the adaptation unless you happen to be there at the right moment. You could not tell from casually looking at the chameleons in the Reptile House that they possessed a marvellous adaptation for catching insects. But if you are lucky you may see them shoot out an enormous tongue, nearly as long as their own bodies. This darts out like a flash, and is sticky at the end. The insect is caught and swallowed before it suspects danger.

The Reptile House provides perhaps the most extraordinary food adaptations of all, in the shape of the jaws of snakes. Snakes, with their huge bodies, would be hard put to it to exist if they were restricted to prey of the size that you would imagine could be swallowed by such a small head. But as a matter of fact they feed on animals far bigger than their own heads. To do this, their jaws are constructed so that the lower can be freely dislocated from the upper, and the two halves of the lower from each other. The prize for detailed adaptation is taken by the egg-eating snake. This swallows birds' eggs many times the size of its own head. In its gullet it has tooth-like spines, formed by projections from the vertebrae of the backbone. When the egg is swallowed, the snake contracts the muscles of its throat. The tooth-like spines break the shell, the contents flow down to the stomach, and then it brings up and rejects the crushed and empty eggshell!

I need not multiply examples. You will be able to see plenty more for yourselves. The point about them all is that the construction of the animal is suited to the kind of food which its instincts prompt it to eat. The animal itself has no influence on its construction. A giraffe is born ready equipped with a long neck and tongue and little millstones for teeth; however much it wanted to, it could not change its construction so as to be adapted for flesh-eating, with cutting teeth and rough tongue and retractile claws like a lion.

All such adaptations have been brought about gradually in the course of evolution by means of the slow sifting process of natural selection. However, to discuss the methods of evolution would be to go right outside the scope of this book. But the results of evolution, of which special adaptations are among the most important, can be admirably studied in the Zoo, and nowhere more clearly than in the case of adaptations to food. All the same, there are plenty of other types of adaptation to mode of life—adaptation to water and to air; to life in trees, deserts, caves, plains, swamps, and so forth; to diurnal or nocturnal life; to arctic or tropical conditions. And I prophesy that keeping a look-out for examples of these will make your visits to the Zoo much more interesting than they would otherwise be.

2

The Colours of Animals

2

The Colours of Animals

IF you look at the mandrill in the Monkey House at the Zoo you will see that he is decorated in a way that to our eyes seems rather startling. His nose is blue and the skin on either side of it is bare and bright red. Below the chin is a pale yellow tuft on a bar of white. The fire salamander in the Reptile House is equally striking in its way—jet black, with blobs and stripes of brilliant orange yellow.

If, on the other hand, you go to the Pheasantry, you will see various pheasants with exquisitely beautiful combinations of colour and pattern—the Amherst pheasant with his black and white, deep green, and brilliant red, the peacock pheasant with lovely little eyespots all over its plumage.

It is impossible not to be impressed with the striking or beautiful colours of many animals, but have you ever asked yourself what the meaning of them may be? Sometimes this is simple enough to guess at. If you go into the sea-water hall of the Aquarium and look at the big tank with the flat fish, you will see soles and flounders and turbot lying half buried in the bottom, and will be at once struck by their resemblance to the sand. So well do they blend with their background that at first you fail to detect quite a lot of them—you see more and more as you look more sharply. Here, obviously, the colour and texture of the fish harmonize with that of the sand on which they normally live, and so help to avoid detection. There are plenty of examples of this concealing coloration to be seen in the Zoo. Shrimps live on sand and are as sandy-coloured as soles; prawns swim among rocks and escape detection by being a translucent green.

Resemblance to sand may be seen in land animals too. The fennec foxes in the North Mammal House come from the Sahara. A naturalist could tell they were desert animals by one look at their pale sandy coats.

A wonderful example of concealing coloration is the frog-mouth in the Bird House, which is so like the stump of an old branch as to be able to sleep away the day in safety when perched on a tree.

Even powerful carnivorous animals may gain benefits from concealment—it gives them a greater likelihood of approaching their prey. As a matter of fact all the large cats show concealing coloration. They also show very prettily, as you may see in the Lion House, how the type of coloration is linked with the normal background of the animal. Lions inhabit plains and open bush country: they are uniform tawny brown. Tigers lurk in bamboo thickets and reed-beds, and their vertical stripes harmonize with the vertical lines of the stems and leaves. Leopards, ocelots, and jaguars live in thick bush or dense forests; they are spotted to correspond with the dappling of the sunflecks through the leaves.

A common method of concealment is the possession of a pattern which breaks up the animal's characteristic outline and makes it disappear into the irregularities of the background. The woodcock is the classical example of this, but, at the moment, there are none in the Zoo. However, the pattern of the angelfish and the pattern of various other fish in the Aquarium will serve as an example. The blotchy patterns of pythons and giraffes and probably the stripes of the zebra serve the same end. An almost universal device is to have the lower side of the body lighter than the upper. This counteracts the tendency of the light to outline the body with dark shadow below, bright light colour above.

One of the refinements of Nature is to endow animals with the power of changing colour, the better to match their background. In the Reptile House is a special exhibition of some of the reptiles and amphibians which possess this power. Here you can see a tree-frog which on a light background turns a bright green, while on a dark background it turns darkish brown. Chameleons behave very similarly, and even our common frog can change from dark chocolate-brown to a light yellowish colour.

But what of the black-and-yellow fire salamander next door, which we mentioned earlier? No one can pretend that his coloration serves for concealment. In fact, it makes him more conspicuous. There are numerous examples known of such obviously conspicuous patterns, and they generally turn out to be associated with some dangerous or unpleasant quality in their possessor. Black and yellow is a very favourite combination, doubtless because it *is* so conspicuous. In the salamander it is associated with glands in the skin which secrete a bitter and rather poisonous substance. Wasps have it too, and they possess a sting. Skunks with their brilliant black-and-white pattern, the white above, are another example; the same type of pattern being seen in the ratels and in the Senegal striped weasel in the Rodent House, both of which have the same kind of nauseating smell as the skunk.

The meaning of colours of this type thus seems to be to give warning that their possessor is not lightly to be attacked, and they are generally called warning colours. Another example, also to be seen in the Reptile House, is the cobra's hood. When the cobra is alarmed, it rears up into the striking position and spreads its hood, on which prominent light markings stand out. But, you may ask, if the animal is distasteful or poisonous, what is the point of giving warning? The answer is that, although the cobra might even kill a buffalo that trod on it, and the salamander would be spat out again by any bird or beast that tried to eat it, they might be damaged or killed themselves in the process. The warning colour acts as an advertisement. In the same way, people who instal burglar alarms generally put up a notice to that effect as well. They prefer that the burglar should be warned and not break in, rather than that he should break in even if he is unsuccessful.

All the colours and patterns I have mentioned so far have been equally developed in both sexes. But there are plenty which only occur in one sex. The mandrill I spoke of at the beginning is only brightly coloured in the male. Here the function of the colour is very similar to that of warning coloration.

However, it is directed not at enemies belonging to a different kind of animal, but at rivals of the same sex and species. We may call it threatening coloration. The principle is the same—to avoid a scrap with its risk of possible injury. If you can *look* formidable enough, your opponent will not run the risk of fighting you. So threatening coloration need not always be an advertisement of real fighting qualities—it can also be just bluff, provided the bluff works. In some male lizards it seems to be almost entirely bluff—rivalries are decided by a look, not by a real fight. But in most cases it is a mixture of the two. A lion's mane not only helps in actual fighting, but makes him look more formidable; the same is true of the antlers of stags, the shaggy forequarters of bull-bison, the beards and whiskers, often brightly coloured, of male monkeys, and the amazing feather frills of the ruffs in the Waders Aviary.

Then certain colours serve as recognition marks, enabling different members of a family or a group to keep together. Most deer, as you may see strikingly in the Virginian deer at Whipsnade, have the under-side of the tail and a patch on the rump coloured white. At rest, the dark upper side of the tail conceals most of this, but when danger threatens they lift the tail as they run off, thus displaying a conspicuous flag. Of course, this makes a mark for the human hunter: but the white signal was not evolved in relation to creatures who could shoot and kill at a distance, but to enemies which had to run after their prey. The same is true of the common rabbit.

Many birds have white or otherwise conspicuous patches on their rump or tail, or on their wings which they only display during flight. These, again, serve to help them to be recognized by others of their kind. The white outer tail-feathers of many species are an obvious example.

Then there are other types of coloration restricted to the male sex, which are directed not against rivals but at potential or actual mates. The brilliant plumage of various cock pheasants, which I spoke of at the outset is an example. In the spring you may often see the cocks displaying before the hens. The male Amherst or the golden pheasant makes a run across the hen's line of sight, spreading and tilting his tail, drooping his wing, and expanding the frill on his head—all on the side towards her. The process is obviously directed *at* the hen bird. The same is true of the display of the peacock, or one type of display of the ruff. The most outstanding displays are given by the birds of paradise in the Bird House, with their gorgeous and fantastic plumage. Some of them even display while hanging upside-down!

People sometimes say that the displays of cock birds can have no meaning, because the females usually take no notice of them. However, one could say the same thing about the effect of advertisement on human beings. Nine hundred and ninety-nine times out of a

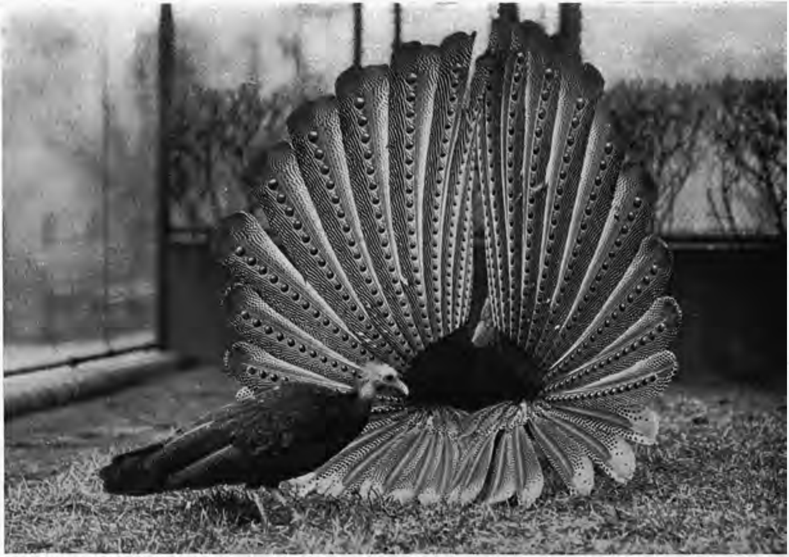

PLATE 4.—The male Argus pheasant advertising his attractions to his mate

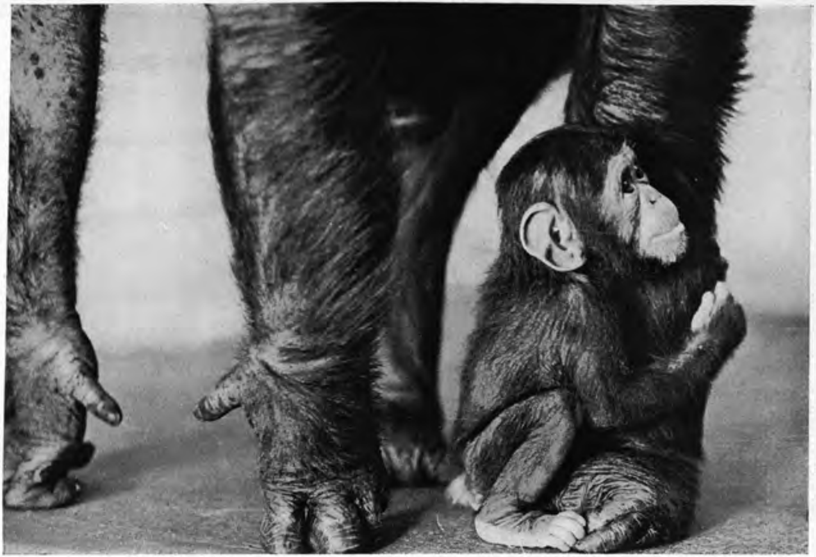

Plate 5.—Jubilee holding Booboo's leg

thousand they seem to have no influence: but when we are about to make a purchase, the advertisement may be decisive. So it is with display. The male is the advertiser: he has to go on whatever happens. The female is usually not in the mood to be moved by his antics. But when the time comes, the display is the decisive factor. This has actually been proved to be so in the case of the ruffs.

For nocturnal animals, scent or light must be substituted for colour. The greenish light of the glow-worms, which you may see in the Ant Island pond on the late opening nights, is emitted only by the wingless females, and serves in nature to attract the winged but almost lightless males.

Often in birds the same colours and patterns serve both for threat and for courtship display, being used differently for the two purposes. This, again, you can see with the ruffs in spring: the frill round the head is expanded in both cases, but a different attitude is adopted according to whether the other bird in the case is a rival male or a hen.

Of course there are a great many colours to be seen in animals for which we can assign no use in the animal's life. Sometimes we can be sure of this, as in the case of the colours of many shells, which in life are invisible because the shells are buried in the sand, or concealed by the bodies of the animals. In other cases, we merely cannot suggest any special use. This is so, for instance, with the bright red of the hermit-crabs to be seen in the Aquarium, or the chestnut and white of the red river-hog in the Ostrich House. And at the meaning of the colours of many birds we can only make guesses.

But there are one or two general points that are worth making about the colours whose meaning we can be sure of. They always exert their effect through the eyes and brains of another animal. Sometimes the other creature is an individual of the same species, as with threatening colours or display colours or recognition colours; sometimes it belongs to another species, as with concealing or warning colours. But this fact that they work through another animal as intermediary is the essential thing about them, biologically speaking. Characters of this nature might just as well work through other senses besides the eye. So besides colours and patterns and shapes, we also find sounds and smells that work in this sort of way. The rattle of the rattlesnake is just as much a warning character as the hood of the cobra. The song of a song-bird is just as much an advertisement to rivals as his bright plumage. Some butterflies use scent in display before the female, instead of bright colours or sounds. Then, because such characters must work through the eyes or other sense organs of another animal, they may tell us something interesting about its senses and its mental processes. The first and most obvious thing they tell us is that many animals must be excited or stimulated by the same sort of things that we find beautiful or exciting. We have only to think of a peacock's train or a thrush's song.

But sometimes they tell us of defects in animals' perceptions. It is at first sight curious that in mammals, except some of the monkeys, the range of colour is extremely restricted. Black, white, reddish brown, yellowish and intermediate shades are all that we find. There are none of the brilliant greens, blues, scarlets, and pure yellows that we find in birds. This would seem to argue that most mammals are colour-blind while birds are not. And recent research has shown that this is true. The same sort of tests that are used in testing for human colour-blindness have shown that most lower mammals can only see in shades of black and white: blues and greens and scarlets would be no good to them. Monkeys and apes on the other hand see in colour; and various of these, like the mandrill and certain monkeys, possess bright and varied coloration.

3

The Stream of Life—Animal Reproduction

3

The Stream of Life—Animal Reproduction

EVERYBODY who goes to the Zoo has a look at Jubilee, the baby chimpanzee. Booboo, her mother, looks after her almost like a human mother. Jubilee, although a good deal more advanced than a human infant of the same age—she is now about sixteen months old—is still very much a baby, and has a long period of childhood before her.

If you go into the Reptile House close by, you will see a remarkable contrast exemplified in the tadpoles in the tanks. They have no mother to look after them; in fact, a frog mother normally never sees any of her offspring. They are put out into the world merely in the shape of little eggs, which have a small store of yolk within themselves on which to carry out their development. They have to find their own food almost as soon as they hatch. They have nothing before them which could be called childhood. They are to all intents and purposes little reflex machines with scarcely any capacity for profiting by experience: all they have to do is to feed and grow. And finally, a female frog produces hundreds of eggs at a time.

It seems extraordinary to us that animals can exist that produce hundreds of young ones which they never even see; but there are even more extraordinary contrasts with our own ways to be found in the reproduction of lower animals. We are so used to reproduction being associated with sex that we often forget that this need by no means be so. In primitive animals reproduction is by growth followed simply by the separation of a part—either by the originally single individual splitting into two new ones, or by the parent producing buds. Unfortunately, such creatures are almost all nearly or quite microscopic, so that they cannot be exhibited in the Zoo. However, on the glass of tanks in the sea-water hall of the Aquarium you may sometimes see little gelatinous rosettes. These are a kind of sea-squirt, living in groups. Each group is produced without sex—by the original member of the group budding off new ones, rather as a strawberry plant produces new plants at the end of its runners.

Even when reproduction is sexual, various queer things—queer, to us that is—may happen. We human beings are permanently either males or females. But snails—the sea-snails in the Aquarium and the land and fresh-water snails in the Insect House—are both male and female at the same time. There is no such thing as a male snail or a female snail: they are all hermaphrodite. Then some creatures even among those belonging to the same background group of animals as ourselves may change their sex. This is by no means unknown in frogs, and among some of the little fresh-water tropical fish like the handsome Swordtail, individuals often begin life as female and later change over to become males, usually after having produced several broods of young in their female capacity.

However, in most Zoo animals, reproduction is firmly tied up with sex, and there are two separate and permanent sexes. What we can trace very prettily in a visit to the Zoo is the tendency, as we go up the animal scale, to reduce the number of young produced, and, at the same time, to expend a greater amount of parental care upon them—the tendency which I illustrated at the beginning in contrasting Jubilee with a tadpole.

In the Aquarium you can see creatures which make even less provision for their offspring than a frog. We are used to hens' eggs, so that we are apt to forget that frogs' eggs are large compared with most. For instance, the starfish and sea-urchins that you may see in the Aquarium produce eggs that are barely visible to the naked eye, and produce them not by the hundred, but by the million. A good-sized sea-urchin lays at one go as many eggs as there are people in London. These eggs are so small because they contain much less yolk than frogs' eggs. Accordingly the developing starfish cannot carry on for a week or ten days like a developing frog on its reserves of food, but has to hatch out and fend for itself after about thirty-six hours, while still microscopic. Here the mother makes the minimum of provision for her offspring. Many fish are almost in the same case, though they provide rather more yolk, and lay eggs by the ten or hundred thousand, not by the million. This holds good for most bony fish. But in some, like the stickleback, the male mounts guard over a nest, so that fewer eggs need be laid.

Perhaps the most extraordinary case is the sea-horse. Here the male has a pouch, to which the female's eggs are transferred after fertilization. The young are protected and also nourished in it, and their birth seems to cause a great deal of discomfort—to the father!

In one of the sea-water tanks in the Aquarium you may see curious leathery objects suspended by curling tendrils at their four corners. These are the egg-cases of skates and dogfish. In these gristly fish only a few eggs are produced. But each egg is packed with yolk till it is as big as a pigeon's egg, and is protected by this tough, leathery case, inside which you may see the little fish safely developing. Not until they are several inches long do the little skates or dogfish hatch out, thus avoiding the infinity of dangers that beset the tiny babies of sole or cod.

Some of the oddest ways of applying parental care to reduce infant mortality are found in the frogs and toads, though most of these take no more care of their young than does our common frog. In the Aquarium you may see the queer flattened leathery creatures known as Surinam toads. In the breeding season the skin of the female's back becomes soft and spongy. She thrusts out a long tube to lay her eggs, and her mate then takes hold of this and uses it like a hose-pipe to spread the eggs over her back. Here they stick; the skin grows up round them, and thus protected they develop, not leaving their safe quarters until they have turned from tadpole-like creatures into tiny toads.

The great problem that confronted our remote ancestors when they first ceased being fish and took to land life, was their reproduction. It is much easier to protect the developed animal against the perils of drying up than it is the tiny and soft-bodied embryo.

The first solution of the problem, found in most amphibians, was a compromise. They are land animals when fully developed, but in their early stages, in the guise of tadpoles, are still to all intents and purposes fish, tied down to water for the beginning of their existence.

Many people think of the reptiles and the amphibians as making but a single group; but there is really a sharp distinction. A newt

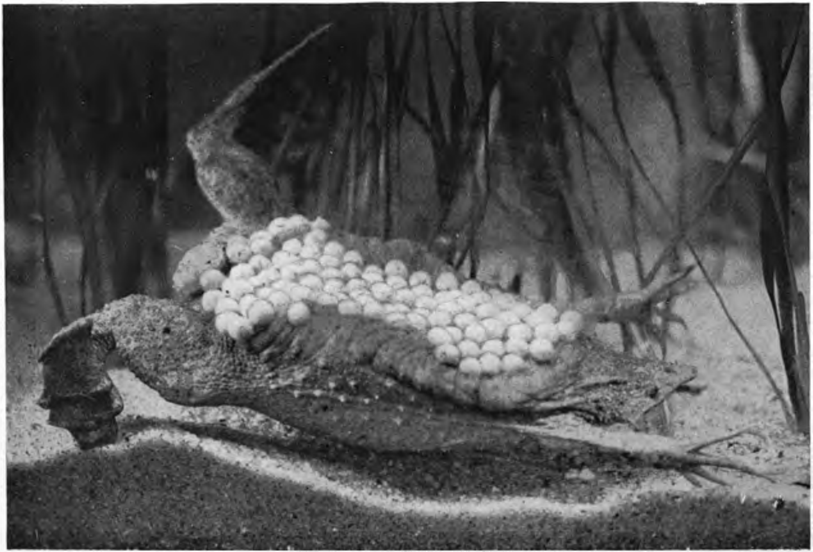

Plate 6.—Female Surinam toad with developing eggs on its back

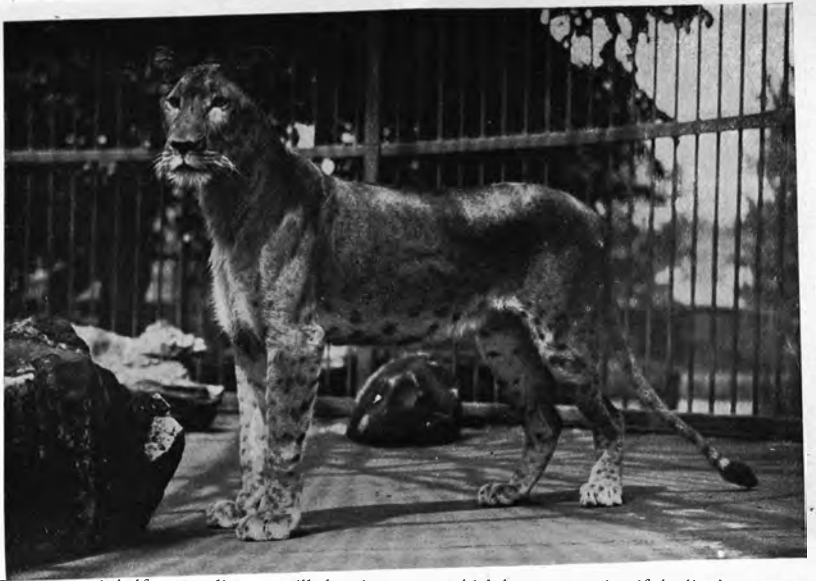

PLATE 7.—A half-grown lioness, still showing spots, which have a meaning if the lion's ancestors were forest dwellers

and a small lizard, as you may see in the Reptile House, look quite alike in general build. But there are fundamental differences between them. The newt's skin is soft and moist, and it has no scales; the lizard's is scaly, hard, and perfectly dry. The newt accordingly must always live in moist places, otherwise it would simply dry up; the lizards lose no water through their anti-desiccation covering. The lizard lays eggs like a bird's, only they are not pointed at one end, and the shell is leathery and tough instead of hard. The egg proper, or yolk, is over a hundred times as big as the newt's egg, and a layer of white or albumen is packed round it.

Accordingly lizards can do two things which are impossible to newts. With the aid of the mass of yolk and white they can develop to a size at which they are able to live in the same sort of way as their parents, before they hatch and have to look after themselves; and they can and do make a little reservoir of liquid inside the egg, where the embryo can pass through its delicate microscopic earliest stages in its own "private pond," and yet the tough shell will keep it from drying up until it has developed a resistant skin of its own.

In the Reptile House you can sometimes see snakes' or lizards' eggs. They aren't much to look at, but they represent one of the greatest advances ever made by life during its upward progress.

Birds have the same general arrangement, but they have gone one better in having the mother bird sit upon the eggs to warm and protect them until they hatch. There are exceptions to every rule, and there are to this. There are some snakes which brood their eggs, and even have their temperature go up a few degrees while doing so. Almost every year a python in the Reptile House lays eggs and goes broody. And there is one family of birds which does not brood its young—the brush turkeys or mound-builders, which you may see on the North Bank at Regent's Park, or in the Bird Sanctuary at Whipsnade. Here the male scratches up a great mound of dead leaves (it is carted away at Whipsnade each year, and proves to weigh 4 to 5 tons!) and the hens lay their eggs in this. The heat of the decaying vegetation serves instead of the heat of the mother's body.

Many birds, like peafowl, cranes, ducks, and so on, have young which run about and feed themselves as soon as they are hatched; but the higher types, like songbirds and crows, have helpless naked young which are fed in the nest by both parents.

This lengthening of the period of dependence is only found in the highest forms of life; it means that fewer young need be produced because they do not have to brave the dangers of the world alone until they have left the most helpless stage of their existence behind. Birds and mammals are the only groups in which both parents look after their young, so that a real family group is formed.

In mammals we can see a wonderful gradation. The lowest mammals, like the echidna in the Rodent House, or the duckbill platypus, although they are quite definitely mammals in possessing hair and suckling their young with milk, still lay eggs. They have remained reptilian in their reproduction. Then come the pouched or marsupial mammals, like opossum, kangaroo, koala, wombat, and so forth. They bring forth their young alive, but the embryo only passes a short time in the mother's body, and is born quite tiny.

A new-born kangaroo is only about an inch long. The unformed young crawls into its mother's pouch, and there develops further.

Finally, in the higher or placental mammals—ourselves and all the more familiar beasts—there is a wonderful arrangement of blood-vessels by means of which the young can be nourished inside the mother's body and so grow to quite a late stage before being born.

Even within the placentals, we can see the tendency at work towards fewer young and greater care. In lower types like mice and hedgehogs, a number of young are born in a litter, and the litters are often at frequent intervals. As we go up the scale the number of young on the whole decreases and the period of dependence increases. Young lions stay with their parents long enough to learn the business of hunting, so that here a true family group persists for quite a time. With monkeys, childhood is again lengthened, and again in apes. It is further lengthened in man, whose period of learning and of plastic immaturity is much longer in relation to his total life than in any other animal.

With the development of a real period of childhood, the play instinct comes to have greater scope. When we see Jubilee's antics or the romps of a family of lion cubs, let us remember that their play has a biological meaning as preparation for the varied business of life.

There is another very interesting point about reproduction and its gradual improvement. In lower forms of life, since the unfertilized eggs are laid freely, there is no need for the sexes to come together. In sea-urchins and sea-worms, sperms as well as eggs are simply shed into the water, and fertilization takes place in the sea without the parents having even been near each other—and even in most fish or amphibia fertilization does not take place until after the eggs are laid.

But once the shelled egg had been evolved, it was necessary for the sexes to come together and for the eggs to be fertilized inside the mother's body, before the white and the shell were put on. And as soon as this happened, the possibility was opened up of the male winning a mate by means of some form of courtship. So all the brilliant colours and wonderful plumes of birds that are used in display before the female owe their existence in the first instance to the development of internal fertilization.

So whether we look at the maternal care of Booboo or the gorgeous display of a peacock, we are reminded of the slow long-range trends to be seen in animal reproduction, which in the course of evolution have gradually reduced the waste of infant lives, enhanced the value of the individual, provided a long childhood for learning, built up the family framework, and added so much of beauty and stimulus to life.

4

Where Animals Come From, and Why

4

Where Animals Come From, and Why

Most people know that kangaroos come from Australia and its near neighbourhood, and from nowhere else. But *why* is this so? If they trouble to ask themselves this question, they will probably either think that there is no particular cause for things being thus, or else they will suggest that kangaroos are for some reason or another specially suited to the country where they are found.

To suggest that there is no reason for a fact of nature is really unscientific ; all nature is a chain of cause and effect. And to suppose that kangaroos are better suited to Australia than Africa or South America is in the first place not true, and in the second place rests on a confusion of ideas.

As I pointed out in the first chapter, animals are suited, often very closely suited, to their way of life and their surroundings; but they are suited to one or other of the types of environment to be found within a geographical area, not to one geographical area as against others. A kangaroo is suited to life on grassy plains, just as a sloth is suited to life in trees, or a lungfish to life in fresh-water ponds that are liable to dry up. But a kangaroo is not suited to Australian plains rather than South American plains any more than a sloth is suited to South American forests rather than to African forests.

An animal is adapted to what biologists call its habitat—a particular kind of country—within its geographical range; but its geographical range is determined by quite other causes.

Let me go back to Australia. It is not only the kangaroos which are peculiar to this region. Almost all the pouched mammals or marsupials—wombats, koala bears, phalangers, Tasmanian devils, and so on—are also confined to this part of the globe, and so are both the egg-laying mammals that exist to-day—the spiny anteater or echidna, which you can see in the Rodent House, and the duckbill platypus.

What is more, almost all the higher or placental mammals, which include all the familiar types like lion, wolf, zebra, pig, rabbit, monkey, and so forth, are absent from the Australian region, apart from man's introduction. But if they are introduced, they do perfectly well—sometimes all too well, as in the case of the rabbit!—showing that the native animals are not there because they are better suited to the place than others.

As a matter of fact, the geographical ranges of animals and their restriction to this or that region depend on historical reasons. It makes sense when we take into account the gradual evolution of different types of animal, and the slow geological changes which have brought about the separation and connection of different land-masses.

We know from fossils that there were no mammals at all until some one hundred and fifty million years ago: it was about then that they first evolved from one of the groups of reptiles. We can also be practically certain that the earliest mammals were of primitive type in still laying eggs. Marsupial mammals, in which the young are born alive but very rudimentary, and have to live for a long time in the mother's pouch, followed several tens of millions of years later. It was not until about seventy million years ago that we find any fossils anywhere of the higher or placental type.

Now the Australian continent was joined to the rest of the world by a land-bridge connecting it with south-east Asia, for a considerable time up till about one hundred million years ago. Then the connection was broken and Australia was cut off. Thus egg-laying and pouched mammals were able to get into it, but the higher mammals were unable to do so—with certain exceptions which prove the rule: bats, which can fly; mice, which seem able to be transported anywhere; man, who can make boats; and the Dingo dog, which, though now wild, seems certainly to have been introduced by man.

Two results followed. In the Australian region, the lower mammals, cut off from competition with more efficient types, had seventy million years or so in which to flourish and to blossom out in their evolution along all sorts of lines which they were unable to achieve elsewhere. Once historical accident had left the marsupials in command of the Australian region, they became adapted to many habitats and ways of life within that region—kangaroos and wallabies to grass-eating on plains; wombats to root-eating and burrowing; Tasmanian devil and Tasmanian wolf to flesh-eating; phalangers to tree life, including some so specialized that they can parachute through the air. There is even a marsupial mole, very like our familiar mole, yet no relation to it. You can see kangaroos, Tasmanian devil, phalanger, flying phalanger, and wombats in the Zoo or at Whipsnade, and reflect on the extraordinary changes which adaptation to way of life can bring about. In general, the same range of types were evolved as in the rest of the world: but in Australia they were all of pouched mammal plan, elsewhere of placental plan.

In the second place, in the rest of the world the egg-laying and pouched mammals went under in competition with the placentals. We find their fossil remains, but no egg-laying mammals survive outside the Australian region, and no marsupials save the opossums and a few other American forms.

The same sort of thing, but on a smaller scale, both in space and time, has happened in Ireland. At the close of the Ice Age, some twenty or twenty-five thousand years ago, the land in western Europe stood higher than it does to-day, so that the British Isles were connected with the continent. But subsidence soon followed. Ireland was first cut off, Great Britain rather later.

As the ice retreated, animals from warmer parts gradually spread through the country. Snakes, none of which can exist close to an ice-cap, were among these invaders; but before any had reached Ireland, the first beginnings of St. George's Channel had been formed, and they could not pass. That, and not St. Patrick, is the reason there are no snakes in Ireland. Our common hare is another central European form which spread westward and was in the same way prevented from reaching Ireland. But the blue or mountain hare, being a northern form and nearer the scene, was able to get in, and now lives even on the low ground in Ireland, whereas in Britain the competition of the common hare keeps it up in the hills.

When bits of land have been permanently isolated from the rest of the land world, then with few exceptions land animals have not been able to reach them at all. This is so, for instance, with New Zealand and with other

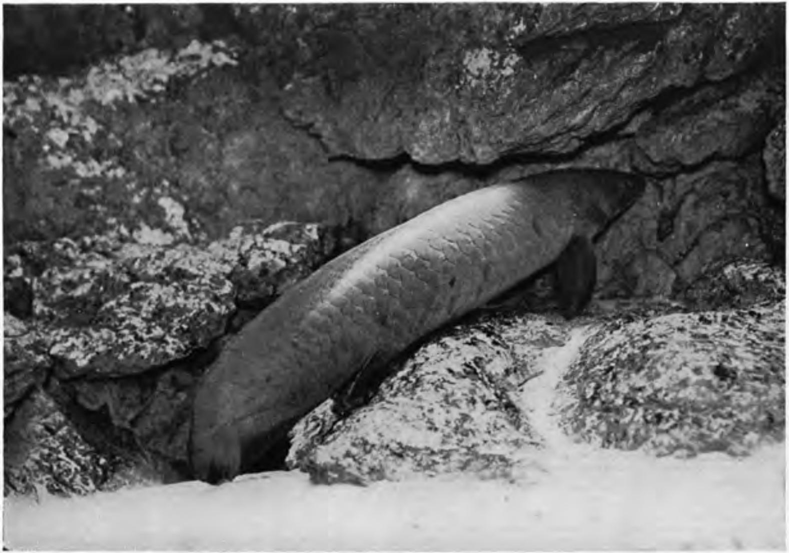

Plate 8.—A linking type between fish and amphibian: the Australian lungfish

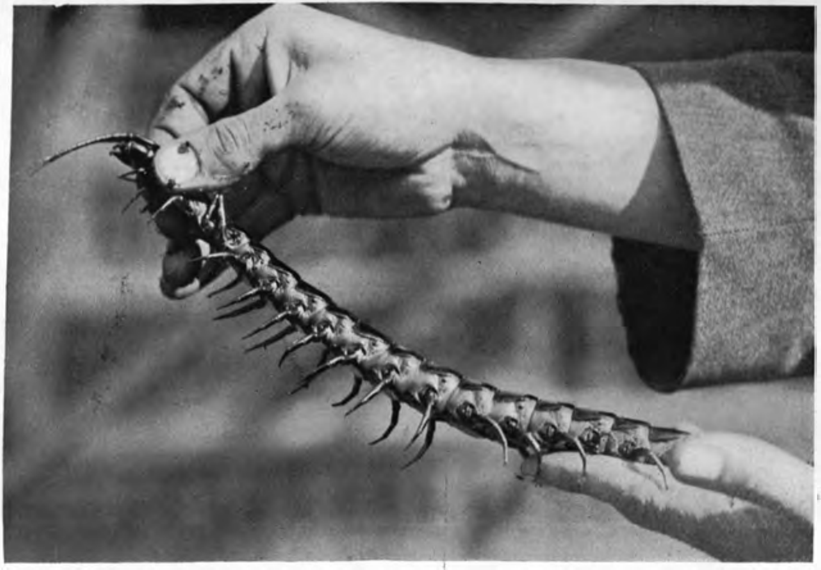

PLATE 9.—Giant centipede: one of the arthropods

oceanic islands, isolated out at sea, like the Galapagos archipelago on the Equator west of South America. There are no native mammals on New Zealand at all except some bats and the ubiquitous mice. And the same is true of the Galapagos. New Zealand, however, is the home of several flightless birds—the kiwi, some flightless rails, and the gigantic moa and its relatives, killed out only a few centuries ago. How did they get there, you may ask, if they cannot fly? The answer, of course, is that they, or rather their ancestors, could fly when they first arrived. But as there were no enemies on the ground such as stoats or foxes, they were able to lose their wings and adapt themselves to a ground life in a way which would have been impossible elsewhere. The same was true of the dodo, now extinct, on Mauritius.

The giant tortoises you can see in the Tortoise House are only found on the Galapagos and some other oceanic islands—different species on different islands. It seems that the reason they could grow to such an enormous size is the same as for the flightlessness of the kiwi and the dodo—the absence of ground-living enemies and competitors.

South America is another region with almost as many kinds of mammals peculiar to it as Australia. To confine ourselves to animals that can be seen in the Zoo, we need only mention great anteaters, armadillos, sloths, llamas, capybaras, guinea-pigs, marmosets, capuchins, and spider-monkeys. The same sort of thing happened here as in Australia, but over a smaller scale of time. South America was cut off from the rest of the world about thirty million years ago, and only reunited again with North America comparatively recently, geologically speaking.

At the time it was isolated, placental mammals were already in existence, but among them the highest types had not evolved. The sloths, armadillos, and anteaters are of a primitive type which got its chance in South America, like the marsupials in Australia, by being freed from undue competition; and the South American members of the group of rodents or gnawing animals, isolated from their relatives, were able to evolve with a number of distinctive types like capybara, agouti, guinea-pig, and Patagonian cavy, quite different from those produced by the rest of the rodent stock elsewhere, such as rabbits, hares, porcupines, beavers, squirrels, and mice. Similarly in South America the ancestral camel stock evolved into llamas, and the ancestral monkey stock into the marmosets and spider-monkeys, while in the rest of the world the one developed into camels, the other into the old world monkeys and baboons, the man-like apes, and man himself.

You will find many examples of special types of animals being confined to special regions where they have been able to evolve along their own lines because of isolation. All the dog-faced or true lemurs came from the island of Madagascar: the antelopes have produced their greatest variety of type in Africa, where the Sahara acts as a barrier; the penguins are confined to the seas of the Southern Hemisphere since they cannot cross the hot equatorial belt.

Isolation for a comparatively short time produces comparatively small changes. In the Bird House you will see a very beautiful and very rare species in the shape of the grey-breasted bird of paradise. This is very like the greater bird of paradise of New Guinea but is restricted to one particular island off the New

Guinea coast. The isolation of island life has allowed the one type to diverge from the other until it has turned into a new species.

Sometimes the change is not even so great as this. Our own island is characterized by many birds that differ definitely but very slightly from the corresponding birds on the continent of Europe. Our familiar pied wagtail, blue tit, bullfinch, and song-thrush for instance, can all be distinguished thus from their continental relatives. The difference here is not big enough to allow us to call them distinct species; we say they are distinct races or sub-species. And we know that these differences have been brought about by evolution in the comparatively short period since Britain was separated from the Continent, something under 15,000 years. The only British bird to have achieved full specific distinction is the red grouse.

Everyone knows that in the course of evolution certain kinds of animals may become extinct. We think of the mammoth and the sabre-toothed tiger from the geologically recent past, the great dinosaur and other dead-and-gone types of reptiles from remoter ages. But an animal type or species may become extinct over part of its range only, so that its present and its past geographical distribution may differ very considerably. Wolves were so abundant and destructive in mediaeval Scotland that veritable crusades against them had to be organized, and travellers were not safe until the forests were burned down only four centuries ago.

Lions ranged over the Near East and into south-eastern Europe in early historic times. The American bison is no longer to be seen on the Great Plains of America, so recently its favourite home. During the Ice Age, hippopotami of various types were found all over the Old World, including Britain.

Sometimes this partial extinction explains features of distribution which would otherwise be extremely puzzling. If you look at the strange lungfish in the Aquarium you will see that there are three distinct types: one comes from Africa, one from South America, one from Australia.

But the study of fossils shows that in remote geological times lungfish of various sorts were found all over the globe. They are in point of fact an early group of fish, once universal, but finally ousted and extinguished by more specialized rivals, everywhere except in these three isolated localities.

The same sort of thing on a smaller scale has happened with the tapirs. Those in the Tapir House at the Zoo belong to a South American group which are all uniformly dark brown in colour. But there is another sort, very similar except that its hindquarters are white, which is found only in the Malayan region. Here, again, fossils give the clue to the puzzle. The tapirs are rather primitive and rather distant relations of the horses. Through almost all of the fifty million years of the Tertiary Epoch they and their ancestors left their bones over most of the area of the globe except Australia. Then, during the Ice Age, for some unexplained reason they became extinct over most of their range, and survive only in two isolated regions of the tropics.

Of course the range of an animal may be extending instead of contracting. Sometimes this is due to man's interference. To take but one example, the house sparrow, after being artificially introduced into the eastern United States, has now spread over most of the Continent. But the spread may be a perfectly natural process. In this country at the present

PLATE 10.—The sloth is an animal specially adapted to forest life

moment the fulmar petrel is spreading quite rapidly round our coasts from its original home in the north; and the nightingale is slowly extending westward into Devon.

But with most animals, recent geological and historical tendency has been towards restriction or extinction. What the rigours of the Ice Age began, man's destructiveness has continued. The only major extensions have been those of man, his associates, and his parasites.

In the Zoo we always put on the label of an animal not only its name but where it comes from. I hope this will have explained why.

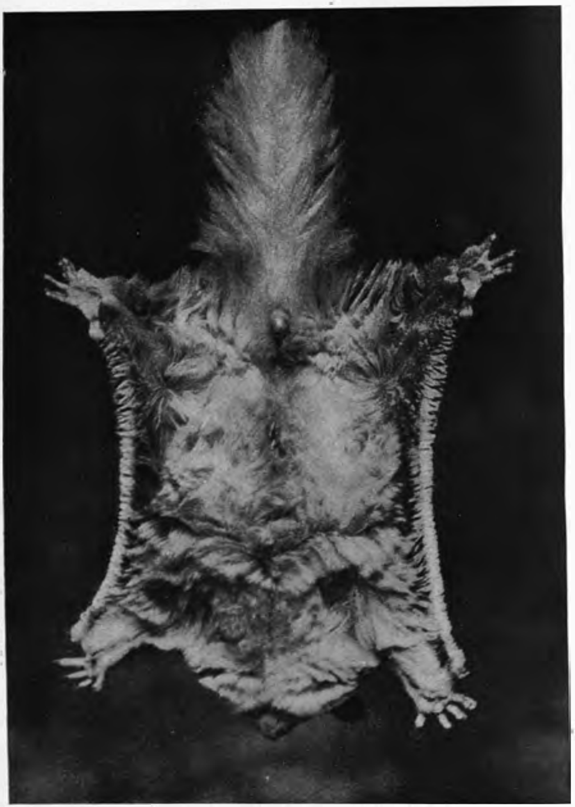

PLATE 11.—Not a mat, but a flying phalanger, whose peculiarities fit it for parachuting through the air

5

Studying Evolution in the Zoo

5

Studying Evolution in the Zoo

By evolution in the Zoo, I do not mean the evolution *of* the Zoo, though that is progressing, and, I hope, is headed in the right direction. Nor, of course, do I mean that you can see evolution actually going on in the animals in the Zoo. Evolution is an excessively slow process that you cannot see going on any more than you can see the hour hand of a watch moving. It took over forty million years for the true horse to evolve out of its little five-toed ancestor, and between half a million and one million years for each amount of change that would warrant our saying that a new kind or species of animal had been produced. Even at its quickest, as in the evolution of new varieties and breeds of domestic animals by man's deliberate selection, it takes many generations to produce and fix a new type. Perhaps one of the functions of a zoo ought to be to undertake the experimental breeding of new types—in other words, artificial evolution.

In many cases, in our living museum at the Zoo we can see many demonstrations that evolution has been at work, and many interesting examples of the way in which it does work. Let us first look at some of the demonstrations. There is generally a family of baby lions to be seen in the Lion House, and, if you visit them, you can see that during most of their first year they are spotted. Now spotting is characteristic of forest animals—think of the jaguar and leopard or the axis deer; the resemblance to the spots and flecks of light in the forest helps to conceal its possessors. So the fact that young lions are spotted has a meaning if the ancestors of lions were forest dwellers, and only later took to the open bush and plains, where a plain tawny coat is a better uniform for invisibility.

Sometimes the facts give evidence of a profounder change. If you visit the Reptile House, you will see the tadpoles of various frogs and toads. Frogs and toads when grown up live on land and breathe by means of their lungs. But to grow up they have to pass through a tadpole stage when they live in the water and breathe like fish by means of gills. Further, although grown-up frogs and toads are tailless, they possess tails in the tadpole stage. In essentials, in fact, a tadpole is built like a fish, and not like a frog or other amphibian. This does not make sense on the idea that animals were created in the form in which they now exist, but is at once understandable if we believe that land animals have evolved from water animals, that amphibians had some kind of fish for their ancestors, and that they accordingly take the path of least resistance by starting life as a fish-like creature, later on changing to the air-breathing amphibian type.

Also in the Reptile House, the boas and pythons provide a very striking proof of evolution, though one that is not very easy to see. On their lower surface, near the vent, they have a pair of claws. Dissection of a dead specimen reveals that these are real claws on the end of the skeleton of a tiny but definite leg. If snakes had always been snakes, this would be impossible to explain; but if, as is certain for many reasons, snakes are descended from lizards which have grown elongated and lost their limbs, then it is not surprising that some of them should keep traces of their leggy past. Such tiny more or less useless organs are called vestigial organs. As a matter of fact, you do not have to go to the Zoo to see an excellent example of a vestigial organ. The short hair over your own body is entirely useless, and absolutely meaningless unless man has evolved from some other kind of animal with well-developed body hair. You have the remains of the skeleton of a tail at the end of your backbone, and before you were born you actually possessed a tiny tail for a considerable period. The opponents of evolution are apt to forget their own embryonic tails.

But to return to the Zoo. When you leave the Reptile House, go into the Seawater Hall in the Aquarium and look at the soles and flounders and other flat fish. They lie flat on one side, and both eyes are on the other side: also their heads look all twisted. This one could understand if they were descended from more ordinary fish which in the course of ages had taken to lying sideways. And, as a matter of fact, each individual flat fish actually runs through this bit of its ancestral history in its own development. It hatches out as a normal-looking baby fish, which swims upright and has an eye on either side of its head.

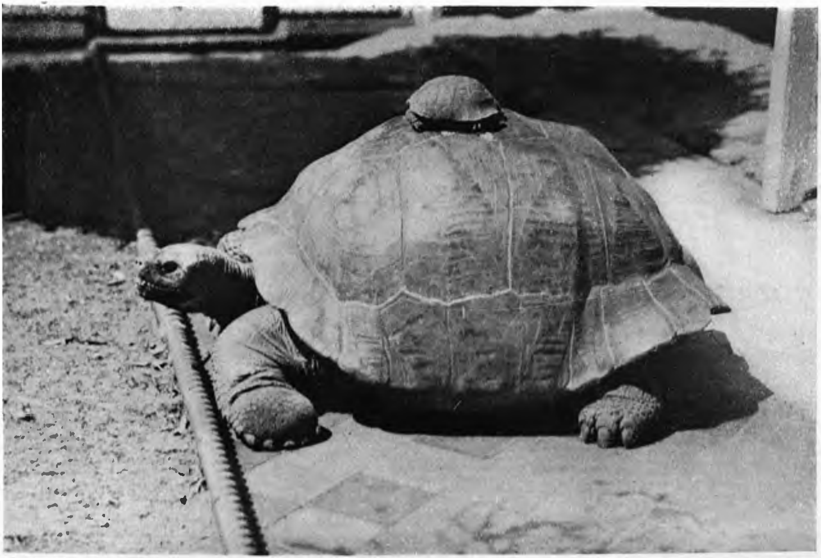

PLATE 12.—Giant tortoise, found only on certain islands where the absence of ground-living enemies enables them to attain an enormous size

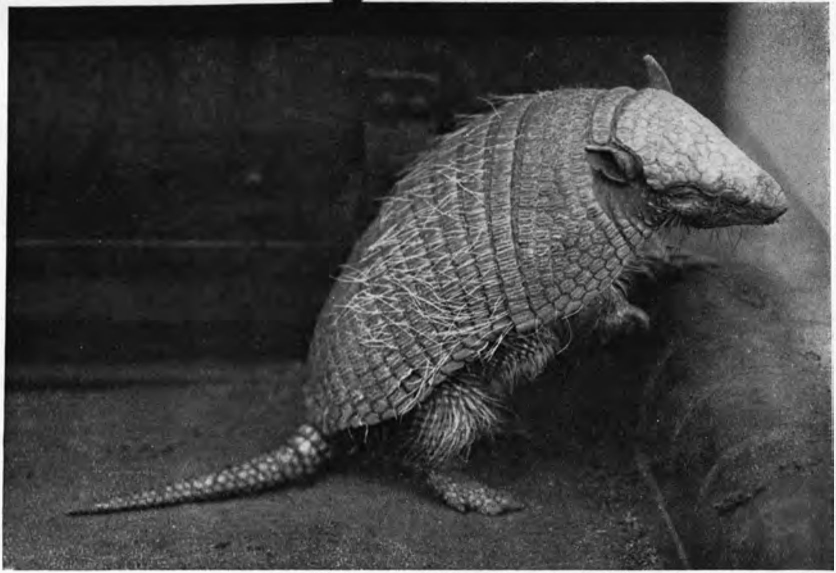

PLATE 13.—The armadillo is a primitive type of animal which got its chance in South America through the absence of undue competition

Gradually it tilts over, the lower eye actually grows round on to the upper side of the head, and finally it settles down to a flat life. This running through of ancestral stages is called recapitulation. As one writer put it, the individual climbs up its own family tree. Our own embryonic tails are examples of recapitulation as well as of vestigial organs. The spots of lion cubs are reminders of an ancestral past, and so are the gills of tadpoles.

Another thing that we should expect if evolution has happened is that we should find linking forms connecting the main types of life. And we do. In the Aquarium you may see such linking forms in the shape of the lungfish. These are true fish, with fins instead of fingers and toes, and gills to breathe with. But their bodies are clumsy and not streamlined, and their fore and hind fins are spaced far apart so that their general build looks much like that of a salamander; and, more remarkable, their swim-bladders, which in other fish act only as gas reservoirs to adjust weight, are modified so that they can be used as lungs if the waters in which the fish live dry up. The lungfish are linking forms between ordinary fish and amphibians.

If you go to the Rodent House, you can see an even more wonderful linking form—the echidna or spiny anteater, an animal that connects reptiles and mammals. The typical reptile is cold-blooded, lays eggs, is covered with scales, and has no milk. The typical mammal is warm-blooded, produces its young alive, has hair instead of scales, and produces milk to suckle its young. The echidna is a mammal all right because it has hair and produces milk. But it is not fully warm-blooded, since its temperature, though above that of its surroundings, goes up and down somewhat with the outside temperature; and it lays eggs with a leathery shell just like a reptile's. It is, in fact, together with its relative the duck-bill platypus, a relic of the earliest type of mammal when it had only half evolved from its reptilian ancestry.

The best examples of evolution at work are given by fossils—the remains of long-dead animals. We at the Zoo only show live animals, so for fossils you must go to a museum like the Natural History Museum at South Kensington. There you will see wonderful evolutionary series, like that of the horses or the elephants. For instance, only the horses from the latest periods have a single hoof. Rather earlier they all have two smaller toes as well; still earlier, three equal toes; and at the beginning of the Tertiary Period, nearly fifty million years ago, they had four toes. They also show a similar gradual change in size, proportions, and type of teeth. Besides this, you can see various striking linking forms that are now extinct. The most wonderful of these is the famous archaeopteryx, which is a true bird with wings and feathers, but resembles a reptile in having teeth, claws on its wings, and a long, jointed tail. I strongly recommend a visit to South Kensington as well as to the Zoo.

The most far-reaching demonstration of evolution in action comes from a study of comparative anatomy and classification. That sounds rather formidable, but really the idea behind it is quite simple. It is this—that all the members of a given group of animals will be found to possess the same general ground-plan of construction irrespective of what use is made of it. For instance, what could look more different than the foot of an antelope, the hand of a man, the wing of a bat, and the flipper of a sea-lion Yet the skeleton of all of them can be reduced to a common plan—one bone in the upper arm, two in the lower, a number in the wrist, and five fingers. The variations are brought about by the enlargement of some parts, as with the bat's fingers, the reduction or loss of others, as in the side toes of the antelope, or the joining of originally separate parts into one, as is the antelope's cannon-bone. The plan is the same, though one is used for running, one for grasping, one for flying, and one for swimming. This only has any meaning if the different creatures are all descended from a common original ancestor possessing this plan for forelimb structure in a simple and primitive form, and that then in the course of evolution they specialized in different directions.

As one would expect, the opposite tendency is also often at work—namely to produce similar-looking organs which yet are built on quite different plans. A whale looks like a fish; but its plan is that of a mammal. A Tasmanian wolf looks like a dog; yet one is a marsupial, the other a placental. The slow-worm looks like a snake, but it is built on the lizard plan—it is a true lizard, which has lost its legs quite independently of the

PLATE 14.—In isolated South America the ancestral camel stock gave rise to the llama, while elsewhere it developed into the camel

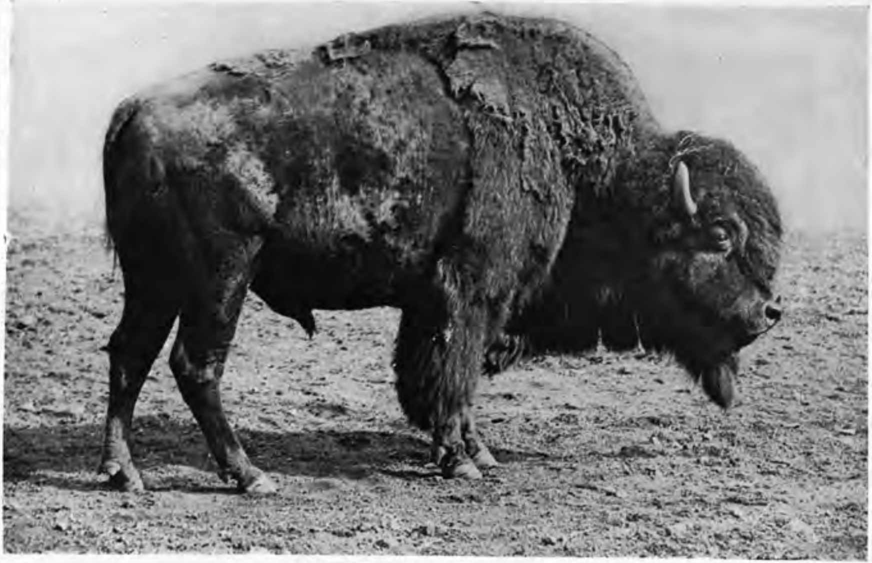

Plate 15.—The American bison

snakes. Insects can fly as well as birds, but their wings are built on a totally different plan.

In any case, common plan of construction comes to mean common ancestry, and the degree of relationship between animals can be estimated by the degree of resemblance between their ground-plans.

It is obvious at once that an antelope, an ox, and a giraffe are all fairly closely related, just as are a lion, a wild cat and a cheetah, or a man, a chimpanzee and a monkey. But all of them resemble each other in certain features—such as possessing hair, and milk-glands to suckle their young. So we group them and other animals with the same features in the single group of mammals.

Going a step farther, all mammals resemble all birds, reptiles, amphibians, and fishes in certain broad features—for instance, in having a backbone, a nerve-cord running along the back, true teeth, one pair of jaws that work up and down, and, typically, two pairs of limbs. We class them all together as vertebrates or backboned animals and conclude that if we followed their ancestors far enough back we should find them all converge in an original primitive vertebrate.

But if you look at a lobster in the Aquarium you will see that its general plan is quite different. It has several pairs of jaws, which move sideways; it has many pairs of many-jointed limbs; and if you dissected it you would find that it had no backbone, and that its nerve-cord ran along its lower surface. A lobster is obviously closely related to a prawn and a shrimp, and also to a crab. But the same general features that mark off its plan from that of vertebrates are shared by spiders, scorpions, centipedes, and insects. So we put all these in a single group—called Anthropods, meaning animals with jointed limbs. This group, then, is another main branch of the animal kingdom, and its evolution for hundreds of millions of years has been quite separate from that of the backboned animals.

There are other major groups of animals, each characterized by its own basic plan—for instance the Molluscs, which include the snails, clams, mussels, and octopus; the Echinoderms, with their five-rayed symmetry, containing creatures like sea-urchins and starfish; or the big group called the Coelenterates, with the sea-anemones, corals, and jelly-fish in it.

Thus the animal kingdom does not represent a single ladder of progress, as used to be thought, but a branching tree. Its evolution has gone on along a number of quite separate main lines. A bee is as highly organized as an octopus or as a lizard—you cannot say that one is higher or lower than the other. But they are organized on quite different systems.

There are, of course, animals which are higher than others—a man is obviously a higher type than a fish, a fish than a sea-anemone. I cannot here go into details as to what constitutes one animal type higher or lower than another, but must content myself with mentioning greater brain-power and more efficient care of the young as two of the main trends of evolutionary progress. However, if you have the general idea of evolution in your head, you will find a visit to the Zoo much more interesting, for the exhibits then become illustrations of a tremendous drama, the drama of life's myriad changes and slow upward progress over a period of at least a thousand million years.

And you may reflect that if the blind forces of past evolution could effect so much, man's conscious powers could, if he set himself the task, achieve even more startling progress in the thousands of millions of years still before him on this planet.

SOME PRESS OPINIONS

" Julian Huxley has given us 'At the Zoo' which should add enormously to the interest of future visits to the Zoological Gardens. The book is both scientific and simple in explanation, and in a short space such matters as the food of animals, the colours of animals, and the evolution of animals are dealt with."—*Country Life*

" These essays are so simply written that they will be intelligible to the juvenile enthusiast yet of profit to the adult. Too many people go to the Zoo without an object. This little book should fill a much needed want."—*Field*

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AT THE ZOO

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AT THE ZOO

Simply written but memorable essays on animal biology. While they arise chiefly out of observations which can be made at the Zoo, they deal with subjects more widely interesting, such as the meaning of colours in animals, animal reproduction, where animals come from, and how we can study evolution at the Zoo. Thus, the book is essential to Zoo visitors and to animal lovers everywhere. The author, who is, of course, well known as a biologist and as a writer, has been Secretary of the London *Zoological Society* since 1935.

(See press opinions on other flap)

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